Appendix F
Distance Calculations for Aesthetics Analysis

1. INTRODUCTION

This appendix discusses the methodology for the visual analysis, which is summarized in Section 4.4, "Aesthetics." The visual simulations for the proposed FSRU were prepared to aid in the assessment of potential visual impacts of the Project, and specifically to determine whether or not all or some portion of the FSRU might be visible from various onshore and offshore locations. Simulations presented in the March 2006 Revised Draft EIR were conducted by Vallier Design Associates of Richmond, California, a firm that has performed numerous project simulations in California. Staff employed a variety of software applications for 3D modeling, CAD, photo editing, and GIS to generate a best approximation of the FSRU set in a spatial model based on real-world data, including land and bathymetric contours, GIS mapping, digital raster graphics, all combined with color photography. As a cross check, views of the FSRU were calculated using an equation to determine the visibility of the FSRU from various points on land (see Table F-1).

After reviewing comments on the Revised Draft EIR, an additional four Key Observation Points (KOPs) were selected to expand the range of observation points, both in distance from the proposed FSRU location and in elevation above sea level. Figure 4.4-20 at the end of Section 4.4 shows the locations of all 18 KOPs. The four new simulations were prepared by Previsualists Inc., a firm with extensive experience in photo simulations that uses the latest tools to assure proper scale, placement, and realism. All created simulations were checked by a California-licensed landscape architect to assure accuracy.

Under ideal conditions, factors that determine whether a viewer can see a distant object include the elevations of the viewer's eye and the observed object, the curvature of the earth, and the distance of the viewer from the object. As illustrated in Figure F-1, a viewer at sea level has a much shorter line of sight than a viewer standing on a bluff adjacent to the shore. Because the California coastline is not a straight line and elevations can range from sea level to more than 3,000 feet (914 meters [m]), the distance to the visual horizon when looking out at the ocean from any given point also varies greatly.

Table F-1 shows the results of applying the distance visibility equation to determine the visibility of the FSRU from various points on shore. As shown, the FSRU would not be visible from points such as the southernmost tip of eastern Anacapa Island or Mandalay Shores but could be visible from locations that are closer and/or higher. However, the visibility calculations are not definitive because of the many factors that affect visibility. Therefore simulation modeling is used to approximate the appearance of the FSRU.

Table F-1 Visibility of FSRU from Various Points on Land

Vantage Point	Eye Height Above Sea Level (feet)	Unobstructed View Distance, or Horizon (NM)[a]	Distance to FSRU from Vantage Point (NM)	Height of FSRU Visible above Horizon (feet)[b]
Southeastern tip of eastern Anacapa Island	5	2.6	18.7	None (FSRU completely below horizon)
On beach at Ormond Beach Generating Station	5	2.6	16.0	33 (20% of FSRU)
Water's edge at Leo Carrillo State Beach	5	2.6	12.01	100 (61% of FSRU)
Mandalay Shores (at Wooley and Mandalay Beach Roads	15	4.5	22.4	None (FSRU completely below horizon)
Oceanview Drive, Port Hueneme	15	4.5	18.7	17 (10.4% of FSRU)
SR 1 near Leo Carrillo State Beach	44.6	7.8	12.2	150 (91.5% of FSRU)
Malibu Bluffs	206	16.8	19.4	159 (97% of FSRU)
Encinal Canyon Road, Malibu	400	23.4	13.1	164 (100% of FSRU)
Anacapa Island, highest point	930	35.7	18.7	164 (100% of FSRU)
Top of Mugu Peak	1,271	41.7	14.1	164 (100% of FSRU)
Top of Saddle Rock	2,160	54.5	17.4	164 (100% of FSRU)
Santa Cruz Island, highest point	2,300	56.1	26.0	164 (100% of FSRU)

[a] Based on formula: (1.17) (square root of eye height in feet) = (distance in nautical miles).

[b] Total height of FSRU is 164 feet above sea level. [Note: 4- to 8-inch diameter cold stack would not be visible from any point on shore.]

1   Due to the curvature of the earth's surface, the formula to calculate the distance of an
2   observer's view to the horizon when looking out over a large body of water such as the
3   ocean is calculated as follows:

> **(1.17) X (square root of eye height (in feet) above the water)   =
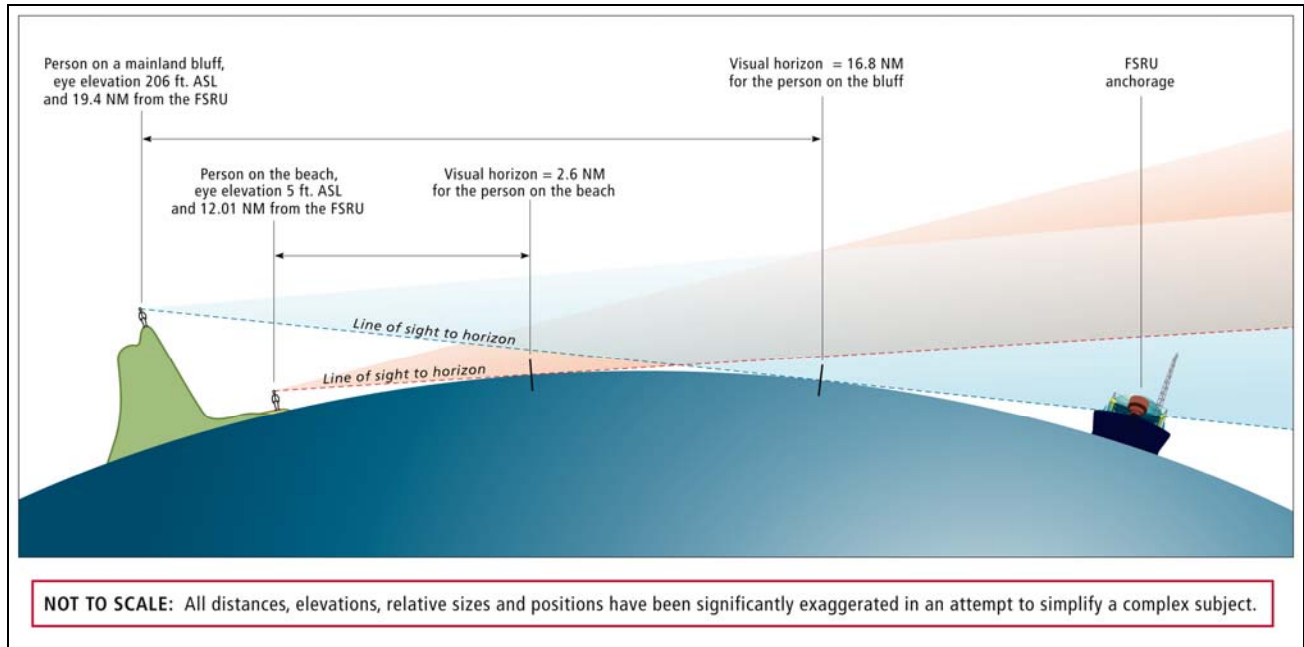> distance to the horizon in nautical miles (NM)**

Figure F-1 Overview of Methodology for Measuring Viewer's Line of Sight

1   In reality, any calculations to determine distance to the horizon or how much of the
2   FSRU would be visible from a given location are only approximations; atmospheric
3   conditions such as variations in temperature, humidity, and atmospheric pressure affect
4   visibility and can reduce a person's apparent visual horizon significantly. Air pollution
5   can also reduce visibility. On the other hand, the effect known as looming (mirages),
6   i.e., when an object "below" the horizon is visible, may occur. Looming causes distant
7   objects to appear larger (and therefore closer) than normal near the horizon over a body
8   of water, particularly when the sun is low in the sky.

9   **2. PROJECT-RELATED VIEWS**

10 **2.1 Project-Related Views from Onshore**

11 To evaluate the visual impacts of the FSRU, visual simulation modeling was initially
12 conducted from two visually sensitive mainland locations: Leo Carrillo State Beach in
13 eastern Ventura County, and Point Dume, about 8 miles (12.9 kilometers [km]) east of
14 the Ventura-Los Angeles County line. Leo Carrillo State Beach is the closest point of
15 the mainland to the proposed FSRU anchorage (12.01 NM [13.83 miles or 22.25 km])
16 and is closer to the FSRU than any of the Channel Islands (the closest of which is
17 Eastern Anacapa Island at 18.7 NM [21.5 miles or 34.7 km] from the FSRU). When one
18 views the Channel Islands from a mainland viewpoint, one cannot see details on the
19 islands (without a telescope or binoculars); only their profile and a somewhat mottled
20 overall color caused by variation in the topography on the islands are visible. Visual
21 analysis was calculated for a person standing near SR1 about 45 feet (13.7 m) above
22 the beach at Leo Carrillo. The second viewpoint where analysis was conducted is Point

1 Dume, about 8 miles (12.9 km) east of the Ventura-Los Angeles County line at an
2 elevation of 44.6 feet (13.6 m).

3 **2.1.1 Visual Analysis at Leo Carrillo State Beach**

4 **(1.17) X (square root of eye height (in feet) above the water**
5 **= distance to the horizon in nautical miles (NM)**

6 Using the formula provided above, if a person stood at the water's edge at Leo Carrillo
7 State Beach and their eyes were 5 feet (1.5 m) above the ground surface, the visual
8 horizon would be at about 2.6 NM (3 miles or 4.8 km), and the water surface at the
9 FSRU mooring location (12.01 NM [13.83 miles or 22.25 km] away) would not be visible
10 as it would be beyond the viewer's horizon, although the viewer could likely see some
11 portion of the FSRU.

12 To determine how much of the FSRU would be visible above the horizon from this
13 location the following equation is presented:

14 In this case, where the eye height is "X,"

15 (1.17) (square root of X feet) = 12.01 NM
16 Square root of X feet = 12.01 NM ÷ 1.17
17 $X \text{ feet} = (12.01 \text{ NM} \div 1.17)^2$
18 $X \text{ feet} = (10.26)^2$
19 X feet = 105

20 From sea level (0 feet above sea level) at the water's edge at Leo Carrillo State Beach,
21 the viewer would be able to see above a point on the FSRU 105 feet (32 m) above the
22 water, or the top 59 feet (18 m) of the FSRU.

23 Because it is more likely that a person of average height would be *standing* at the
24 water's edge, their eyes would be approximately 5 feet (1.5 m) above sea level.
25 Therefore, the visual horizon of that person (i.e., 2.6 NM) has to be subtracted from the
26 overall distance between the FSRU and the vantage point, i.e., 12 − 2.6 = 9.4 NM.
27 Therefore, using the formula above:

28 (1.17) (square root of X) = 9.4
29 Square root of X = 9.4 ÷ 1.17
30 $X = (9.4 \div 1.17)^2$
31 $X = (8.0)^2$
32 X = 64 feet

33 The results of the equation indicate that a person standing on the water's edge could be
34 able to see above a point on the FSRU 64 feet above the water surface; in other words
35 the top 100 feet of the FSRU (164 − 64 = 100).

1 **2.1.2 Visual Analysis at Point Dume**

2 The elevation of the viewpoint at Point Dume is 44.6 feet above sea level.   An
3 observer's unobstructed view to the horizon would be approximately 7.8 NM, and the
4 distance to the FSRU from this location is approximately 14.2 NM. From this viewpoint,
5 most of the FSRU's profile would be visible above the horizon as calculated below.
6 Similar to the calculations done for Leo Carrillo, one subtracts the visual horizon of the
7 observer (in this case 7.8 NM) from the overall distance of 14.2 NM, which equals 6.4:

8 $$(1.17) \text{ (square root of X)} = 6.4$$
9 $$\text{Square root of X} = 6.4 \div 1.17$$
10 $$X = (6.4 \div 1.17)^2$$
11 $$X = (5.47)^2$$
12 $$X = 29.9 \text{ feet}$$

13 This means that someone standing at this bluff location at Point Dume should be able to
14 see a point on the FSRU roughly 30 feet above the water surface, or the top 134 feet of
15 the FSRU (164 – 30 = 134).

16 **2.1.3 Visual Analysis at Malibu Bluffs**

17 The elevation of Malibu Bluffs is approximately 201 feet above sea level. If a person
18 stood at the top of the bluffs his or her eyes would be approximately 206 feet (62.8 m)
19 above the ocean surface, and his or her unobstructed visual horizon would be about
20 16.8 NM (19.3 miles or 31.1 km). From this vantage point most of the FSRU (located
21 19.4 NM [22.3 miles or 35.9 km] away) would be visible, as follows:

22 $$(1.17) \text{ (square root of X feet)} = 2.6 \text{ NM}$$
23 $$\text{Square root of X feet} = 2.6 \div 1.17$$
24 $$X \text{ feet} = (2.6 \div 1.17)^2$$
25 $$X = (2.2)^2$$
26 $$X = 5 \text{ feet}$$

27 This means that someone standing on top of Malibu Bluffs should be able to see a point
28 on the FSRU 5 feet above the water surface; in other words the top 159 feet of the
29 FSRU (164 – 5 = 159).

30 **2.1.4 Visual Analysis at Additional Onshore Locations**

31 In response to public comments on the March 2006 Revised Draft EIR, photographs
32 were taken from four higher elevations, and three new simulations were prepared. A
33 simulation was not prepared for one location where there was no direct line of sight to
34 Cabrillo Port.

1   Figure F-2 (KOP 15) presents the view from Mugu Peak in Point Mugu State Park at an
2   elevation of 1,266 feet. This viewpoint is about 16.2 miles north of Cabrillo Port.

Figure F-2 View Offshore from Mugu Peak in the Point Mugu State Park (KOP 15)

1   Figure F-3 (KOP 16) presents the view from Sandstone Peak in the Santa Monica
2   Mountains National Recreation Area (NRA) at an elevation of 3,111 feet. This viewpoint
3   is about 19 miles north-northeast of Cabrillo Port, and the FSRU would be entirely
4   above the visual horizon.

Figure F-3 View Offshore from Sandstone Peak in the Santa Monica Mountains NRA (KOP 16)

1   Figure F-4 (KOP 17) presents the view from Triunfo Lookout in the Santa Monica
2   Mountains NRA at an elevation of 2,545 feet. This viewpoint is about 18.2 miles north-
3   northeast of Cabrillo Port, and the FSRU would be entirely above the visual horizon.
4   This KOP is only about a mile southeast of KOP 16 (Sandstone Peak).

Figure F-4 View Offshore from Triunfo Lookout in the Santa Monica Mountains NRA (KOP 17)

1   Figure F-5 (KOP 18) presents the view from the water tank at the Malibu Country Club
2   in the Santa Monica Mountains NRA at an elevation of 1,830 feet. This viewpoint is
3   about 19.6 miles northeast of Cabrillo Port. Views in the direction of Cabrillo Port would
4   be mostly obscured by the presence of mountains in the middle ground; therefore, a
5   simulation for this location is not feasible. This point was chosen in lieu of a similar
6   viewpoint at nearby Saddle Rock that is not legally accessible to the public.

Figure F-5 View offshore from the water tank at the Malibu Country Club (KOP 18)

7   **2.1.5 Methodology Used for Visual Analysis at Additional Onshore Locations**

8   There are three important and distinct objectives in making the photo simulations
9   accurate: the horizontal placement (where the FSRU is placed from side to side); the
10 vertical placement (how close it is to the foreground or the horizon); and the scale (size)
11 of the FSRU. This text briefly describes how the consultant achieved accuracy on each
12 viewpoint shown in Section 2.1.4 and confirmed each with a double-check.

13 Each viewpoint site was photographed with a scale reference in the photo, and GPS
14 measurements provided both viewpoint and proposed port locations.   Horizontal
15 placement was achieved by locating landmarks on an aerial photo and confirmed by on-
16 site notations. Vertical placement and scale were exacted using a 3D horizon model,
17 and scale was confirmed by the scale reference.

18 The four viewpoints were visited and the viewpoint GPS coordinates recorded. On site,
19 the Garmin GPSMAP 60CSx GPS unit pointed toward the Cabrillo Port coordinates,
20 providing direction with the pointer arrow, bearing with the compass, and distance.

1 Each view was photographed, and a scale reference indicator was placed in each view
2 and re-photographed.

3 Using a black rectangle on a piece of paper, a 1/5280th scale of the visible silhouette of
4 the FSRU was created, 2.20682 inches long (11,652 inches long divided by 5,280) and
5 0.366 inches high, at the exact trigonometric ratio of the distance from the viewpoint to
6 Cabrillo Port. For example, at Sandstone Peak, the rectangle was photographed 19.0
7 feet from the camera because the port is 19.0 miles from that viewpoint. This method
8 provides the exact scale that the Cabrillo Port would appear from each location,
9 regardless of lens selection, cropping, or scaling.

10

11 Prominent landmarks were noted on each digital photograph. These landmarks and
12 viewpoints were then found on a high-resolution aerial photograph. This provided a
13 measurement—an angle between landmarks, with the apex of the angle at the
14 viewpoint. The more landmarks the more accurate the angles are. These multiple
15 landmarks were placed with corresponding degree lines on the final photograph. A
16 wide-angle photo would have more lines, as it would be closer to a 90 degree view. A
17 telephoto lens would only give a view closer to 10 degrees, so there would only be ten
18 vertical lines across the image. Regardless of the type of lens that was used, the
19 degree lines corresponded to the correct viewpoint and landmarks.

20 A 3D model was constructed replicating the curvature of the earth, using a radius of
21 3,963 miles. A revolved sphere was used, making the revolution in 360 steps
22 (indicating degrees) radiating from 0,0,0. A rectangle representing the size of the
23 Cabrillo Port was placed on the model, representing the distance away from each
24 viewpoint: Sandstone Point at 19.0 miles, Triunfo at 18.2 miles, Malibu at 19.6 miles,
25 and Mugu at 16.2 miles. The viewpoints were then moved vertically to represent the
26 elevation from which each photo was taken: Sandstone Point at 3,111 feet, Triunfo at
27 2,545 feet, Malibu at 1,930 feet, and Mugu at 1,266 feet. The images were then
28 captured after turning "on" only the rectangle that corresponded to the labeled
29 viewpoint.
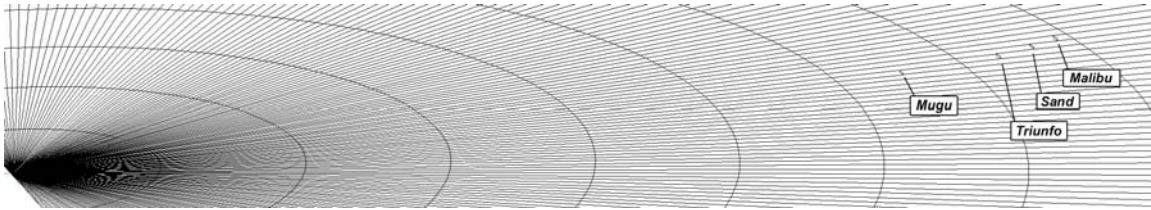
1

2 These rendered images from the 3D model accurately provided the exact scale of the
3 FSRU in relation to the degree lines, and accurately place the port vertically on the
4 horizon line.
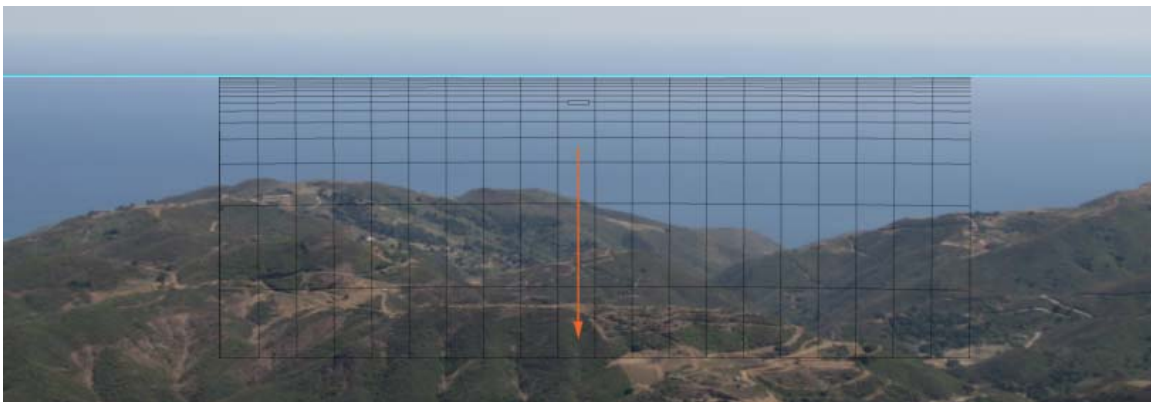
5

6 Each rendered image was overlaid onto the photograph and aligned with the degree
7 lines. The horizon of the rendered image was placed on the horizon of the photograph
8 to provide an exact scale and vertical placement of the Cabrillo Port. The scale was
9 then confirmed by comparing it to the black rectangle in the photograph; in each case it
10 was exact.

11 **2.1.6 Impacts to Viewsheds of Onshore State Parks**

12 From the vantage point of Mugu Rock, (elevation ~55' ASL), one would have a visible
13 horizon at about 9 NM. The FSRU location is beyond that point at about 13.7 NM west-
14 southwest of Mugu Rock, "below" the horizon. But due to the increased eye height of
15 an observer at Mugu Rock, one would be able to see roughly the top 68 feet of the
16 Moss tanks under clear conditions.

17 La Jolla Canyon runs roughly northwest to southeast behind Mugu Peak and the
18 associated ridge line; therefore, there would be no direct line of sight to the proposed
19 FSRU anchorage from La Jolla Canyon. Atop Mugu Peak one would have a clear line
20 of sight to the FSRU, but at a distance of slightly over 14 NM the FSRU, under typical
21 marine meteorological conditions, would be a ship-like small object on the horizon.

1 Boney Ridge in Point Mugu State Park is even more distant from the FSRU being about
2 4 miles east-northeast of Mugu Peak. The same is true for other Santa Monica
3 Mountains NRA areas mentioned, all well east and north of Mugu Peak.

4 **2.2 Project-Related Views from Offshore**

5 A viewer on a small boat can calculate the distance to an object if the eye height and
6 the height of the object are known. Using the same formula, they would calculate the
7 distance to their visual horizon and the distance from the object to the horizon and add
8 the two together. Therefore, assuming the viewer's eyes are 5 feet (1.5 m) above sea
9 level and the top of the object is 164 feet (50 m) above sea level, the distance to the
10 object would be:

11 | **(1.17) X (square root of eye height (in feet) above the water   =** |
12 | **distance to the horizon in nautical miles (NM)** |

13 ((1.17) (square root of 5)) + ((1.17) (square root of 164)) =
14 ((1.17) (2.236)) + ((1.17) (12.806)) =
15 (2.616) + (14.983) =
16 17.6 NM

17 This means that the person in the boat would begin to see the FSRU from
18 approximately 17.6 NM away. Using these same formulas, if the viewer's eye height
19 and distance to the FSRU are known, how much of the FSRU would be visible at any
20 given point can be determined. For example, if the small boat was 11.8 NM from the
21 FSRU, then:

22 ((1.17) (square root of 5)) + ((1.17) (square root of X)) = 11.8
23 (2.616) + ((1.17) (square root of X)) = 11.8
24 (1.17) (square root of X) = 11.8 – 2.616
25 (1.17) (square root of X) = 9.184
26 Square root of X = 9.184 ÷ 1.17
27 Square root of X = 7.85
28 X = 7.852
29 X = 62 feet

30 Therefore, the viewer would be able to see above a point on the FSRU 62 feet (19 m)
31 above sea level or, in this case, from the main deck to the tops of the Moss tanks.

32 **3. SUMMARY**

33 At all onshore locations the FSRU would appear as a small, featureless object on the
34 horizon, and often would not even be visible due to typical hazy atmospheric conditions
35 in the area. Also, because of the distance, details of the FSRU would not be
36 discernible. When visible, it would most likely appear to be a vessel in the shipping
37 lanes because of its location in a marine environment. The FSRU would have a slightly

1   larger profile than a typical LNG carrier. At a distance of at least 12 NM (the closest
2   point of land on the mainland), it would be difficult if not impossible to distinguish two
3   separate vessels. Figure F-6 compares the size of the Cabrillo FSRU and a typical
4   cruise ship. Table 4.3-1 contains information on the number and representative sizes of
5   ships in the shipping channel.

6   Simulations of the FSRU from higher elevations at distances similar to those from Leo
7   Carrillo State Beach and the Malibu Bluffs would not result in substantially different
8   views because what the human eye can see from these distances, regardless of
9   elevation, would not be detectable. At offshore locations, a person in a boat would
10 begin to see the FSRU from approximately 17.6 NM away. At 11.8 NM from the FSRU,
11 a viewer on a small boat would be able to see above a point on the FSRU 62 feet (19
12 m) above sea level, or from the main deck to the tops of the Moss tanks.

963' Carnival Spirit
(typical large cruise ship)

971' Cabrillo Port FSRU

Figure F-6 Size Comparison of the FSRU and a Typical Cruise Ship